HJ 5119
S5 N3

Ae

Cornell University Library
HD 5119.S5N3

Hours of work as related to output and h

3 1924 013 870 781 mann

Hours of Work as Related to Output and Health of Workers

SILK MANUFACTURING

Research Report Number 16
March, 1919

National Industrial
Conference Board

New York
State College of Agriculture
At Cornell University
Ithaca, N. Y.

Library

HOURS OF WORK AS RELATED TO OUTPUT AND HEALTH OF WORKERS

Silk Manufacturing

RESEARCH REPORT NUMBER 16
MARCH, 1919

Copyright 1919

NATIONAL INDUSTRIAL CONFERENCE BOARD
15 BEACON STREET
BOSTON, MASS.

Cornell University Library

The original of this book is in
the Cornell University Library.

There are no known copyright restrictions in
the United States on the use of the text.

http://www.archive.org/details/cu31924013870781

CONTENTS

PAGE

FOREWORD vii
INTRODUCTION 1
  STATISTICAL BASIS OF THIS REPORT 2
  GENERAL FEATURES OF SILK MANUFACTURING 3
    SOURCE AND PREPARATION OF SILK 6
  PRINCIPAL PROCESSES OF SILK MANUFACTURING 7
    THROWN SILKS 7
    SPUN SILKS 10
    FATIGUE FACTORS 11
  PRESENT HOURS OF WORK IN THE SILK INDUSTRY 11
    SATURDAY HALF HOLIDAY 12
    NOMINAL AND ACTUAL HOURS 12

HOURS AND OUTPUT 15
  THE 50-HOUR GROUP 16
  THE 52½-HOUR GROUP 16
  THE 54-HOUR GROUP 17
  THE 55-HOUR GROUP 18
  FACTORS BEARING ON EFFICIENCY 18
    MACHINE EFFICIENCY 22
    RELATIVE EFFICIENCY OF PIECEWORK AND DAYWORK 23

STATISTICAL DATA AS TO OUTPUT 26
  DIFFICULTIES OF SECURING COMPARABLE DATA 26
  COMPARISONS OF OUTPUT OF INDIVIDUAL ESTABLISHMENTS 28-35

CONCLUSIONS AS TO OUTPUT 37

HEALTH OF SILK-MILL WORKERS 39
  GENERAL HEALTH CONDITIONS IN THE INDUSTRY 40
  ACCIDENT HAZARD 44
  CONCLUSIONS AS TO HEALTH 44

APPENDIX 47

LIST OF TABLES

PAGE

TABLE 1: Geographical Distribution of Establishments and Employees Covered by the Investigation, 1917 2

TABLE 2: Geographical Distribution of Silk Manufacturing Establishments; United States Census, 1914 2

TABLE 3: Establishments and Employees, Grouped According to Nominal Hours of Work per Week 12

TABLE 4: Percentage of Nominal Time Actually Worked During 55 and 50-Hour Weeks in Mills A and B, and 54 and 51-Hour Weeks in Mill C 13

TABLE 5: Summary of Changes in Output Accompanying Reductions in Hours of Work, by Hour-Groups 15

TABLE 6: Comparison of Weekly Output of a Broad-Silk Mill for 10 Weeks under a 55-Hour Schedule with that for an 11-Weeks Period under a 50-Hour Schedule 28

TABLE 7: Comparison of Weekly Output of a Large Velvet Mill for Two 10-Week Periods under a 55-Hour and a 50-Hour Schedule Respectively. 30

TABLE 8: Comparison of Weekly Output of a Broad-Silk Mill for a 6-Weeks Period under a 55-Hour Schedule with that for a 6-Weeks Period under a 50-Hour Schedule 31

TABLE 9: Comparison of Weekly Output of a Broad-Silk Mill for Three Months under a 55-Hour Schedule with that for Three Months under a 50-Hour Schedule. 32

TABLE 10: Comparison of Weekly Output of a Broad-Silk Mill for Two Months under a 55-Hour Schedule and for Three Months under a 50-Hour Schedule 33

PAGE

TABLE 11: Comparison of Weekly Output of a Throwing Mill for Six Months under a 54-Hour Schedule with that for a Similar Period under a 50-Hour Schedule 34

TABLE 12: Summary of Output Data Covering Reductions in Ten Establishments from a 55 to a 50-Hour Week 36

TABLE 13: Percentage of Deaths of Males and Females Due to Tuberculosis, of the Total Mortality for the Silk, Wool, and Cotton Industries and for all Manufacturing and Mechanical Pursuits, by Age Groups, U. S. Census, 1909 41

TABLE 14: Percentages of Deaths of Male Silk-Workers from Certain Causes, 1897 to 1900, Compared with Similar Percentages for 79 Selected Occupations, as shown by the Industrial Experience of the Prudential Insurance Company . . . 42

Foreword

THIS report is the fourth of a series which the National Industrial Conference Board is preparing, based on an investigation of the hours-of-work problem in major industries.

The purpose of the investigation is to establish the facts of this controversial subject and to present such conclusions as are clearly warranted by a scientific analysis of these established facts. The investigation was not undertaken with the intention of attacking or defending a workday of any specific length, but, instead, to assemble the available results of actual experience.

The discussion of hours of work should be sharply distinguished from that of a basic workday. The latter is primarily a wages problem, but is often confused with the problem of determining what number of hours of work per day or per week will be most productive without impairing the health of workers.

Conclusions as to the proper length of the workday, moreover, must take into account not only the effect on output and on health, but also the need of the worker for a reasonable period of leisure for recreation, home life, and self-development.

The problem varies so widely in different industries — because of differences in type of worker, in character of product, in management, and particularly in the extent to which automatic machine processes influence results,— that the experience of any one industry must not be taken as representative of industry in general.

Hours of Work as Related to Output and Health of Workers

SILK MANUFACTURING

INTRODUCTION

The Board's investigation of the hours-of-work problem in the silk manufacturing industry was conducted along the same general lines as the earlier investigations in the cotton[1] and wool[2] manufacturing industries. The results of the silk investigation, however, present a striking contrast with those for the two other textile industries studied.

In the northern cotton industry, reductions to less than 56 hours per week involved a general loss in ouput in more than 90% of the establishments[3] and in a majority of cases this loss was approximately proportional to the reduction in time. Again, in the wool industry, a reduction to a 54-hour schedule resulted in a general loss in output, though the loss was somewhat less pronounced than in the cotton industry.

In the silk industry, however, a considerable proportion of the mills reported output maintained after substantial shortening of schedules to less than 54 hours per week, in a number of cases, indeed, to 50 hours per week.

In the wool and northern cotton industries, moreover, the predominating schedule was 54 hours per week, whereas in the silk industry a large majority of the mills reporting were on a 50-hour schedule. It is, therefore, on this group that interest centers, and one important feature of the investigation was to ascertain the reasons for the difference in results.

---

[1] Research Report No. 4 — Hours of Work as Related to Output and Health of Workers, Cotton Manufacturing.

[2] Research Report No. 12 — Hours of Work as Related to Output and Health of Workers, Wool Manufacturing.

[3] Throughout this report the word "establishment" is used to designate a corporation, partnership, or individual submitting a schedule. When a single management operating several plants returned a consolidated schedule, this was necessarily treated as one establishment.

STATISTICAL BASIS OF THIS REPORT

Schedules of inquiry were addressed to members of the Silk Association of America. Replies, stating the results of reductions in hours, were received from 71 establishments employing 30,095 workers.[1] This information was supplemented by reports of field agents who visited a large number of mills; 13 of these establishments employing 5,230 operatives did not file schedules. In all, the report covers 84 establishments, employing 32.7% of the total silk-mill workers in the United States as shown in the 1914 Census of Manufactures. A classification, by states, of establishments and of employees follows:

TABLE I: GEOGRAPHICAL DISTRIBUTION OF ESTABLISHMENTS AND EMPLOYEES COVERED BY THE INVESTIGATION, 1917

(National Industrial Conference Board)

States	Establishments		Employees	
	Number	Percent	Number	Percent
Total	84	100.0	35,325	100.0
Pennsylvania	19	22.6	12,740	36.1
New Jersey	39	46.4	10,439	29.6
Connecticut	12	14.3	8,872	25.1
New York	9	10.7	1,912	5.4
Massachusetts	3	3.6	1,074	3.0
Maine	1	1.2	139	.4
Maryland	1	1.2	149	.4

The industry is largely centered in New Jersey, Pennsylvania, New York, and Connecticut.[2] The distribution

---

[1] This total includes all factory employees, but does not include office, sales, or engineering forces.

[2] The distribution of the silk industry in 1914 as shown by the U. S. Census of Manufactures is given in the following table:

TABLE 2: GEOGRAPHICAL DISTRIBUTION OF SILK MANUFACTURING ESTABLISHMENTS IN THE UNITED STATES, 1914

(Compiled from data given in the U. S. Census of Manufactures, 1914)

States	Establishments		Employees	
	Number	Percent	Number	Percent
Total	902	100.0	108,170	100.0
Pennsylvania	284	31.5	44,755	41.4
New Jersey	368	40.8	28,263	26.1
Connecticut	44	4.9	10,668	9.9
New York	143	15.8	11,659	10.8
Massachusetts	19	2.1	4,495	4.1
Maryland	5	.6	874	.8
All other states *a*	39	4.3	7,456	6.9

a Includes California 1; Delaware, 1; Georgia, 1; Illinois, 3; Maine, 1; Michigan, 2; New Hampshire, 2; North Carolina, 4; Ohio, 1; Rhode Island, 12; Virginia, 9; West Virginia, 1; Wisconsin, 1.

of establishments covered by the investigation is therefore representative.

The 84 establishments upon which this report is based furnished definite information reflecting the judgment of the respective manufacturers as based upon experience. The data were supplemented by statistical comparisons of output supplied by a considerable number of establishments. The information assembled, therefore, affords ample basis for valid conclusions.

The length of the work-week is, of course, only one of many factors that affect output. In making output comparisons to show the effects of shortened schedules, it is usually desirable to compare periods shortly before and shortly after reductions in hours, thus avoiding or minimizing the effects of many of the collateral factors such as changes in personnel, season, or materials. The experience should, however, cover a sufficient period to make the results fairly representative.

Output obviously is not the sole test of the justification of any given hours-of-work schedule; the social needs of the worker must likewise be carefully considered. The broad social aspects of the hours-of-work problem are of great importance. They may, however, be more intelligently dealt with if the facts as to output and health are first clearly determined. It is the purpose of this report to assist in establishing the facts on these points, leaving the social factors, which are less susceptible to statistical treatment, for later discussion.

GENERAL FEATURES OF SILK MANUFACTURING

Hand time feature of the work. Silk manufacturing on the whole involves more handwork and consequently production is more dependent upon the skill and general efficiency of the worker than in cotton and wool manufacturing. In some processes, however, the machine dominates. In a few processes, indeed, the machine may be said to control output.

As in cotton manufacturing it is sometimes possible to run certain machines unattended for a time, but silk yarn as a rule is so delicate that breakages necessitate a relatively large amount of handwork, particularly in weaving. It is said that, on the average, a silk weaver spends one-third of his time repairing broken threads or remedying other disturbances in the warp. The percentage of the theoretical maximum efficiency[1] generally attainable in silk weaving is, therefore, rather low as compared with cotton weaving. With good warp an automatic cotton loom may run practically all day without stopping, attaining an efficiency of perhaps 98%; indeed, by running unattended for a time at noon or after nominal closing time, efficiency for a nominal day may rise considerably above 100%. No such efficiencies are reported in silk weaving.

The amount of hand time varies with the individual and with the material being worked. Some processes are almost exclusively handwork. Speaking in general, the machine almost controls output in spinning. In weaving, the machine also frequently dominates, but the operative is a much more important factor than in spinning. In such processes as sorting, trimming, inspecting, cutting, and folding, handwork clearly controls output.

Size of silk establishments. A striking feature of the silk industry is the wide range in size, equipment, and general arrangement of the plants. In a large percentage of cases, weaving and throwing[2] are done by different establishments. Many weaving mills purchase their yarn or have it thrown on commission. Not infrequently a number of very small establishments are located in a single building. The capital and equipment essential to the operation of such mills, especially if engaged in a restricted or special line of work, may be small as compared with the amount usually required in either the cotton or wool industries. This is a consequence of the highly specialized nature of the industry, the great value of the product, and the opportunity for personality and individual skill. On the other hand, a mill doing general silk manufacturing is necessarily elaborate and costly. Particularly noteworthy is the intricacy and massiveness of some of the machinery required in such a mill. The raw silk is, of course, very

[1] The percentage efficiency of a loom for any particular kind of product during a given period may be approximately determined by comparing the actual number of picks (filling, or woof yarns) woven with the maximum possible number that could have been woven had the looms worked at their known speed without any stoppages whatever.

[2] The process of making yarn from reeled raw silk; from the Saxon word "thrawan," meaning to twist.

much more costly than the raw material used in any other textile industry and, on the whole, the overhead manufacturing charges are heavy.[1]

High percentage of women and minors. The number of women and minors employed in the industry is larger than for either cotton or wool manufacturing. The Census of Manufactures in 1914 showed that approximately 54% of the total work-force were women, and over 7% minors under sixteen years of age. In those establishments making a specialty of throwing, characteristic of certain regions of Pennsylvania, for example, the percentage of women and children is considerably higher than the average. So high a percentage of women and minors clearly introduces a special consideration into a study of the hours-of-labor problem.

Compilations based on data for the 84 establishments reporting show close agreement with the figures of the United States Census of Manufactures with respect to the proportion of men, women, and minors employed.

(National Industrial Conference Board)

	N. I. C. B. 1917		Census, 1914	
	Number	Percent	Number	Percent
Total	33,775[a]	100.0	108,170	100.0
Men	13,564	40.2	41,599	38.5
Women	18,280	54.1	58,763	54.3
Boys	657	1.9	2,499	2.3
Girls	1,274	3.8	5,309	4.9

[a] Four establishments employing 1,550 persons failed to make returns concerning the division of their employees into men, women, boys, and girls.

Wages. The average wages of silk-mill workers before the war were higher than for cotton-mill workers but lower than for wool-mill operatives. They also ranked low among other leading industries. Compilations made from the United States Census of Manufactures, 1914, show that the average annual earnings of silk-mill workers were approximately 27% below the average for 20 leading industries.[2] It should be pointed out, however, that a portion of the workers were unskilled and fitted only for comparatively simple tasks where the physical effort is light.

---

[1] According to the data given in the U. S. Census of Manufactures, 1914, the total capital invested in the silk industry was $210,072,000, as against $867,044,000 for cotton manufacturing and $389,653,000 for woolens and worsteds. The value of the products for the same year were $254,011,000, $676,569,000 and $379,484,000 respectively. The proportion of these values added by manufacture was as follows: silk, 75.9%; cotton, 56.8%; wool, 54.0%.

[2] The industries were those standing first in value of products.

During the war substantial increases of wages were made in the silk industry as in practically all other industries. Changes in rates of wages accompanying reductions in hours are noted in the Appendix.

SOURCE AND PREPARATION OF SILK

All of the natural silk[1] used in the United States is imported.[2] Broadly speaking, it falls into two classes: (*a*) Reeled-raw[3] silk, which goes to throwing mills to be made into yarn, and (*b*) silk waste, which includes all unreelable cocoons and parts of cocoons, and manufacturing waste from which spun-silk yarns are made by processes similar to other textile spinning.

[1] Silk is chiefly produced by the *Bombyx mori* under domestication. The worm envelopes itself in a cocoon by exuding, from its under-lip, two fine thread-like streams of fluid which unite to form a single strand. The cocoon is completed in about three days. The worm then enters the chrysalis stage and changes within a fortnight into a moth which, unless killed, breaks its way out of the cocoon, injuring the silk fibers and rendering them unreelable. A cocoon from which the moth has thus escaped is called a "pierced cocoon" and is classified as silk waste. In order to prevent this piercing of the cocoons about 98% of the worms are killed by heat, thus preserving the continuity of the fiber. Normally a cocoon has, in addition to much waste fiber, a continuous filament of reelable silk from 300 to 700 yards in length. So fine are the silk filaments that, if placed end to end, a single pound might measure 1,000 to 1,500 miles, or even more. In order to render the fibers commercially useful, several are in the reeling process simultaneously unwound from their respective cocoons and, by the aid of the natural gum with which they are coated, combined into one thread.

Artificial or imitation silk is fiber of finer strand than natural silk, obtained from a cellulose base by chemical process. The yarn does not stand the strain of warping as well as natural silk yarn and its use in the various processes of manufacture should not be long delayed. Prior to the beginning of the war the greater part of the artificial silk used in the United States was imported. Recently, however, imports have been reduced and the manufacture of artificial silk has increased. According to the Semi-Annual Report of The Silk Association of America, 1918, the importations of yarns fell from 2,780,063 pounds in the fiscal year 1914–1915 to 293,421 pounds in 1917–1918. Reports from other sources indicate that the domestic manufacture increased from 320,000 pounds in 1914 to 6,500,000 pounds in 1917. Returns from establishments making artificial silk are not included in the statistical compilations of this report.

[2] Compilations made from Information Series No. 3 of the U. S. Tariff Commission show that silk imports for the fiscal year ending June 30, 1917, totaled 40,351,423 pounds, valued at $160,571,808, distributed as follows: Reeled-raw silk for thrown yarn 33,868,885 pounds; silk cocoons and waste for spun yarn 6,482,538 pounds.

[3] Reeling, which requires much handwork, is not commercially possible in this country. The low wages prevailing in China, Japan, and Italy, the main sources of the raw silk used in America, effectively discourage any attempt to establish this tedious but important process of manufacture in the United States. Spun-silk manufacturing is, however, an important part of the silk industry in America. This is possible for the reason that in spun-yarn manufacture, as in throwing and weaving, machinery rather than handwork plays the leading part.

PRINCIPAL PROCESSES OF SILK MANUFACTURING

THROWN SILKS

The term throwing as used in the silk industry includes the series of operations by which reeled or raw silk is made into yarn. It is essentially a spinning or twisting process including various doubling processes, by which several raw silk threads are combined. In other textile spinning the process involves a drawing or attenuating of the roving and then twisting it into yarns. In reeled raw silk, however, the threads or fibers have already been formed by the silkworm and no drawing is possible.

The chief products of throwing mills are organzine and tram.[1] Organzine is silk especially twisted for use as warp. Two or more raw silk threads which have already been twisted in the single are doubled and then twisted the reverse way. Tram is often made of poorer qualities of silk and is used for filling. Single untwisted threads are loosely twisted together and unlike organzine require only one spinning.

The principal processes of silk manufacturing with reference to fatigue and health hazards of operatives may be briefly described as follows:[2]

Winding: After soaking the raw silk to soften the gum which adheres to it, and drying it—processes performed by unskilled labor and almost exclusively by men—the skeins are placed on hexagonal power reels and wound on spools or bobbins attached to rapidly revolving spindles.[3] The work of winding consists of putting the skeins on swifts, as they are called, joining the ends of broken fibers, removing the bobbins when filled and replacing them with empty ones. Ordinarily one winder will tend from 50 to 90 reels or swifts. The usual number is 72. The work, which is usually performed by women and girls, is simple and light, but it ordinarily requires close attention on the part of the operative, with almost constant activity, and some stooping.

---

[1] An important branch of the silk industry is the manufacture of sewing and embroidery silks. The several kinds are the results of as many methods of handling raw silk. Though differing materially among themselves from a technical standpoint, they involve no new principles, and are essentially matters of doubling, winding, and twisting. Some spun-silk thread is also made in this country.

[2] The machinery and procedure necessarily vary in the several processes of silk manufacture. Moreover, there are some processes which while important, perhaps even essential, are, nevertheless, relatively minor operations. In this report it is obviously impracticable to attempt to discuss the industry in detail. Accordingly some operations are not included in the description of processes.

[3] Silk is also put through a similar process, often called "soft silk winding," at a later stage in the manufacture of silk fabrics.

Spinning: In first-time spinning, the silk as wound on bobbins by the winding frames is rewound on other bobbins and at the same time given a certain number of twists per inch. A spinner tends from a few hundred to approximately a thousand spindles, the number varying with the quality of its fiber and size of the yarn. The work consists chiefly in piecing broken thread and in changing bobbins. In case a thread becomes broken the bobbin affected is automatically stopped. This also happens when the bobbin has been wound full. Thus the threads can be pieced together for a particular bobbin, or a bobbin can be removed without interfering with the operation of any other spindles on the frame. Because of the large number of spindles attended and the high rate of speed, sometimes more than 10,000 revolutions per minute, the operative must constantly walk up and down the aisle, and in remedying trouble much stooping is required. While in some localities many men are engaged in spinning, women are chiefly employed.

Second-time spinning is substantially similar to first-time spinning, but with the twist in the opposite direction, doubling two or more strands together.

Doubling is the uniting of two or more strands into a loose thread. It is very similar to winding and is light, semi-skilled work largely performed by women and girls.

Reeling: The process of reeling consists merely in unwinding the thread from the bobbin and rewinding on a hexagonal frame or reel so that it may be dyed. The work of the operative consists in putting the bobbins in the proper position on the winding frame, in straightening the threads in case they become snarled, and in tying ends of broken threads.

Considerable manual effort is required in lifting the reels from the frames and carrying them to benches for the subsequent process of lacing.[1] Where girls or young women are employed in reeling it is customary to have men handle the reels, since they weigh twenty pounds or more. These workers are called "reel carriers" and usually do nothing else. Where men are employed for the reeling proper, however, they also handle the reels.

Quilling is essentially another form of winding and consists in transferring the silk threads from bobbins to small spools or quills which are placed in the shuttles of the looms. An empty quill is placed on the bobbin and when wound full with thread is removed and replaced with another empty one. Women and girls are almost exclusively engaged in this work and there is opportunity to sit perhaps one-fourth of the time. Close inspection and the removal of all dust and dirt from the machinery constitute an important part of the operative's duties.

---

[1] Lacing, which is light work usually performed by children and new employees, consists in dividing the skeins into a number of parts by passing short strings between the strands of thread. Bundling consists in twisting the skeins into tight rolls and packing them into bundles preparatory to dyeing. This work is light but calls for considerable judgment and dexterity. An important feature is the detection of imperfections in the thread.

Warping: Silk warping is the process of unwinding warp threads from the spools on which they were wound in the doubling and spinning process and placing them methodically on loom beams. The work consists mainly in removing rough threads and knots, and in repairing broken threads. It involves constant standing and considerable bending over, though there are intervals of inactivity.

Drawing-in and Twisting-in: The process of drawing-in consists in passing the ends of warp threads through the eyes of the harness and the reeds of the loom. It is skilled work. Hand twisting-in is the process of uniting, by twisting, the thousands of new threads with the corresponding ends of the piece of fabric just completed. The work, which is highly skilled labor, is done while sitting and requires much reaching. Both men and women are employed.

Weaving: Plain silk weaving is very similar to plain cotton and wool weaving. On account of the adaptability of the Jacquard loom to weaving a great variety of patterns, that form of loom is extensively employed. Although in Jacquard weaving the threads are automatically controlled by perforated cards, there is, nevertheless, great opportunity for skill on the part of the operative, particularly in watchfulness to prevent unnecessary breakage and in promptly repairing threads which become broken. In addition the operative must, of course, keep the shuttles filled with quills.

Partly because of the peculiar properties of silk and partly because of the higher value of the product which makes spoiled work more costly, silk weavers do not tend as many looms as weavers in cotton mills. In the Paterson, N. J., district ordinarily not more than two looms are tended by a single operative. This, however, is apparently a result of arbitrary restrictions by labor organizations in that district, as four and even five looms are frequently tended by a single operative in other localities.[1] To catch defects in warp and filling, and generally supervise the operation of the loom, requires constant attention, though, of course, the amount of actual physical effort varies with the material, style of fabrics, number of looms, and, by no means least, with the skill and alertness of the weaver himself. An efficient weaver can obviate a large amount of unnecessary labor.

[1] Where, however, the two-loom system prevails the fabric is, as a rule, fancy and elaborate.

Both men and women are extensively employed in weaving.

Dyeing: In general, silk is dyed either in the yarn or in the piece.[1] Dyeing is sometimes done by hand manipulation of the fabrics in dye vats or by running the silk through dye by power-driven reels. Silk dyeing lacks mechanical precision and as a rule is fatiguing work, so that very few women are employed; daywork wages largely prevail.

Printing: Printing is done by means of engraved designs on copper cylinders, a separate cylinder being used for each color. The cloth is then passed through in a manner somewhat resembling the feeding of paper into a cylinder printing press. The colors are set by steam. The work is performed by men.

Cloth Picking: The cloth as it comes off the loom contains rough ends of threads which have to be picked off. In addition, grease stains and dirt spots have to be removed. Picking is, on the whole, light work, requiring skill; it is performed by women and girls. After this, the goods are put through what is called the finishing process by which glue is deposited upon the cloth by means of a steam atomizer; many other finishing processes are also employed. The fabric is then pressed by hot rolls to make it smooth and at the same time give it the luster or gloss which characterizes it in its commercial form. Finishing is skilled work generally performed by men.

Beyond this are several comparatively simple processes of preparing the silks for shipment. This work is generally performed by women.

SPUN SILKS

The manufacture of spun silk involves more work, both hand and machine, than does the manufacture of thrown silk. Moreover, the highly developed state of the raw silk fiber from which thrown silk yarns are made renders unnecessary many of the involved processes required in the manufacture of spun silk and other yarns such as cotton and worsteds.

As already pointed out, those mills which use silk waste instead of reeled fiber have to prepare the waste and spin it. The process called dressing is in many respects similar to the preparation of cotton or wool, but differs in some cases, particularly in that the waste has to be boiled, usually in a solution of soapsuds in order to remove the natural silk gum and to cleanse it from dirt and impurities. After drying, the mass is run through revolving cylinders which pull the fibers apart, straighten them, and leave them in the form of sheets or laps. These sheets are later cut into short lengths, automatically hung over small rods, in which position they are combed and cleaned and later run into laps of several feet each. In this form the laps are taken to the spinning mill and drawn into a loose strand called sliver. The mass is put through roving frames and is wound on bobbins. It is then run through the spinning frame. This process is similar to those described in previous reports of the Board on cotton and wool manufacturing. Among the subsequent processes is gassing, in which fuzz is removed from the thread by gas flame. The yarn is also passed through a machine for removing knots, after which it may be reeled and woven.

---

[1] Weighting of silk is usually done in connection with the dyeing, by the addition of metallic salts or by use of vegetable or organic matter deposited in the fiber, sometimes to the extent of half the weight of the silk. Silk is usually weighted in the skein; piece-dyed goods are but little weighted.

FATIGUE FACTORS

Most of the heavy work in the silk industry is performed by men. As was pointed out by various manufacturers, however, the physical condition of a worker, the degree of fitness to perform a certain task, often is much more of a fatigue factor than is the mere physical effort normally required for that operation. In every mill there are operatives who appear to suffer fatigue while engaged in comparatively light work, while others will finish a day of much heavier work with little or no noticeable fatigue. Again, as in other factory industries, noise, monotony, poor ventilation, standing, reaching, stooping, eye-strain, etc., alone or in combination, may cause serious fatigue. Sometimes the operatives most exposed to these objectionable conditions are women and children, who suffer in consequence considerable fatigue, although the required physical effort may be light.

As noted elsewhere, good lighting and cleanliness are essential to the efficient conduct of the industry. On the whole, the silk manufacturing industry compares very favorably with manufacturing in general; many mills, indeed, are excellently constructed and arranged. There is some unguarded machinery, but probably not more than in other industries where machinery plays a leading part.

PRESENT HOURS OF WORK IN THE SILK INDUSTRY

Of the 84 establishments covered by this report 64, or 76.2%, were on schedules of from 50 to 52½ hours per week. In 55 establishments the hours were 50 and in three others they differed from this schedule by only a fraction of an hour.[1] In other words, a 50-hour week was in force in practically two-thirds of the establishments included in the investigation.

---

[1] These 58 establishments are hereinafter treated as composing the 50-hour group.

Only about 3.4% of the workers were in establishments where the weekly schedule was more than 54 hours.

TABLE 3: ESTABLISHMENTS AND EMPLOYEES, GROUPED ACCORDING TO NOMINAL HOURS OF WORK PER WEEK

(National Industrial Conference Board)

Nominal Weekly Hours of Work [a]	Establishments		Employees	
	Number	Percent	Number	Percent
Total	84	100.0	35,325	100.0
50 [b]	58	69.0	22,717	64.3
51	1	1.2	263	.7
52½ [c]	5	6.0	3,641	10.3
54 [d]	11	13.1	7,513	21.3
55	9	10.7	1,191	3.4

[a] A number of establishments designate regular periods, usually a half-hour per week, for cleaning machinery, etc., the actual operating time thus becoming correspondingly less than the nominal hours.

[b] In 1 of these mills the hours were 50½.

[c] In 2 of these mills the hours were 52¾.

[d] In 1 of these mills the hours were 53¾.

The high percentage of women and minors, the exacting character of the work, and the specific demands of labor have all contributed to the rather general observance of the 50-hour schedule. Only about one-fifth of the mills covered by this investigation are running on schedules as high as the legal limitation of working hours for women in their respective states, and in these mills the schedules for men and women are the same. In no establishment were the nominal hours for men higher than for women.

SATURDAY HALF HOLIDAY

In the silk industry as in the northern cotton and wool industries the Saturday half holiday is almost universally observed. Without exception, the 84 establishments covered by this report make provision for closing at about noon on Saturday. Furthermore, with the exception of five plants, all of the establishments had observed the Saturday half holiday prior to the latest reduction in hours.

NOMINAL AND ACTUAL HOURS

The average actual hours of workers in any silk mill show some variation from week to week. Normally, of course, the actual hours are somewhat less than the nominal hours. This margin in the silk industry is not due to general absence among the work-force at any given time, but reflects the absence of a varying proportion of the force in any given week, averaged over the entire number. The great majority of workers put in practically the full nominal schedule. Many employers, recognizing that more or less absence is inevitable, endeavor to keep substitute hands available for the more important tasks.

The margin between actual and nominal hours appears to be fairly constant, irrespective of the length of the nominal factory schedule. A comparison for three establishments representing three distinct geographic sections of the industry before and after reductions in nominal hours, is given in Table 4. It will be noted that there was no marked difference in the percentage of lost time when hours were shortened.

TABLE 4: PERCENTAGE OF NOMINAL TIME ACTUALLY WORKED DURING 55 AND 50-HOUR WEEKS IN MILLS A AND B, AND 54 AND 51-HOUR WEEKS IN MILL C

(National Industrial Conference Board)

	Before reducing nominal hours		After reducing nominal hours	
	Number of operatives	Percent full time worked	Number of operatives	Percent full time worked
MILL A		a		b
Whole Mill	269	94.7	238	94.6
Men	209	95.1	170	94.6
Women	60	94.0	68	94.8
MILL B		c		d
Whole mill	184	88.0	224	86.4
Men	36	89.4	37	90.8
Women	148	87.6	187	85.6
MILL C		e		f
Whole mill	228	90.9	163	92.7
Men	41	95.2	23	97.2
Women	187	90.0	140	92.2

Mill A. *a*. Velvets, Connecticut. Full or nominal time, September, 1916, 55 hours per week.
b. Full or nominal time, September, 1917, 50 hours per week.
Mill B. *c*. Silk ribbons, Paterson, N. J. Full or nominal time, September, 1915, 55 hours per week.
d. Full or nominal time, September, 1916, 50 hours per week.
Mill C. *e*. Broad silks. Pennsylvania. Full or nominal time, September, 1917, 54 hours per week.
f. Full or nominal time, September, 1918, 51 hours per week.
The foregoing percentages are not given as being necessarily representative.

Time spent in a silk mill is, of course, not necessarily all spent in physical effort. While silk operatives have on the whole less opportunity for rest during working hours than do cotton or even wool workers, there are, nevertheless, intervals in which relaxation is possible. In some processes these intervals are considerable. Undue weight should not, however, be attached to mere freedom from actual physical effort, for often the chief fatigue factor, even under excellent working conditions, is not so much actual physical effort as it is the tension of continued watching, of being constantly on the alert. These considerations obviously have a bearing on the determination of the proper length of the workday.

The silk industry as a whole is subject to considerable variations in the number of workers employed, but these variations cannot be said to be seasonal; rather they are the reflection of market prices and conditions in general.

HOURS AND OUTPUT

Of 84 establishments which reported the effect on output accompanying reductions in hours of work, two reported that production was increased, 17 that it was maintained, and 65 that it was reduced. A summary table in the Appendix epitomizes the results as reported by the managements of the several establishments. The reductions in weekly schedules covered by the report, with two exceptions, occurred during the period from 1909 to 1917; the greater number were made in 1916.

Of the 84 establishments covered by the report, 58, employing 69% of the total number of workers, reduced to 50 hours, one reduced to 51 hours, five to 52½ hours, eleven to 54 hours, and nine to 55 hours.

Table 5 shows the various hour-groups and compares

TABLE 5: SUMMARY OF CHANGES IN OUTPUT ACCOMPANYING REDUCTIONS IN HOURS OF WORK, BY HOUR-GROUPS

(National Industrial Conference Board)

	Production Maintained or Increased*			Production Decreased		
	Previous hours	Number establishments	Number employees	Previous hours	Number establishments	Number employees
	55	*2*	*359*			
Reduced to 50 Hours	55	6 } 7	3,139	55	35 } 49	14,563
	54	1	268	54	14	4,388
Reduced to 51 Hours	54	1	263			
Reduced to 52½ Hours	55	2 } 3	1,255	55	2	977
	54	1	1,409			
				60	2 } 8	570
Reduced to 54 Hours	56	1 } 3	842	58	5	4,172
	55	2	1,244	56	1	685
				60	4 } 6	630
Reduced to 55 Hours	60	1 } 3	168	58	1	149
	58	2	173	57½	1	71
Establishments . .		19			65	
Employees			9,120			26,205
Percent of establishments		22.6			77.4	
Percent of employees			25.8			74.2

*Increase shown in italics.

the number of employees and the previous hours of the establishments maintaining output, when hours were reduced, with similar data from the establishments reporting that production was decreased.

This table shows that for approximately one-quarter of the establishments reporting, output was maintained (or in two cases increased), while in the remaining three-quarters a decrease was reported. The proportions of employees in the two groups were approximately similar. In order to make an intelligent analysis of these figures, however, it is necessary to take up the discussion by hour-groups.

THE 50-HOUR GROUP

As stated at the beginning of this report, it is in the 50-hour group of establishments that interest centers. It is the largest group; its mills cover a wide range of size and represent every branch as well as every important manufacturing district of the industry.[1] In nine of the 58 mills in this group output was maintained, two of the nine, in fact, showed an increase, while in 23 others the decrease in output was relatively less than the reduction in hours, although in several of the 23 cases the loss was substantial. These 32 establishments employed approximately 68% of the employees in the 50-hour group or about 44% of the number in all groups covered by the investigation. The data indicate that reduction to a 50-hour work-week in the silk manufacturing industry has in a great majority of cases resulted in a decrease in output. Taking the industry as a whole, however, there has undoubtedly been some gain in the efficiency of the workers and, in consequence, the loss in output was less than proportional to the reduction in hours.

THE 52½-HOUR GROUP

In the 52½-hour group, three establishments reported output maintained, while two reported that it was decreased; all were large plants. One mill of the three maintaining production attributed a part of its gain in efficiency to a bonus system and to a system of rest periods; in another the actual reduction in time was only one hour and fifteen minutes, effected by extending the lunch period. The weight of the evidence for this group, though obviously far too limited to be accepted as conclusive, is in favor of the shorter schedule.

---

[1] The geographical distribution of the mills in the 50-hour group is as follows: New Jersey, 36; New York, 7; Pennsylvania, 8; Connecticut, 5; Massachusetts, 2.

Only one mill reduced to 51 hours; consequently no deductions concerning this schedule can be made, but the fact that it maintained output gains some significance when considered in connection with the 50 and 52½-hour groups.

THE 54-HOUR GROUP

In the 54-hour group, eight establishments reported that output was decreased and three that it was maintained. Of these three mills two made a reduction of only one hour each by closing earlier on Saturday; in one of the two there was considerable change in the working force which appeared to increase the average efficiency. In four of the eight mills in this group reporting a decrease in output, the loss was less, proportionally, than the reduction in time. The eight mills reporting output as decreased, with one exception, reduced from either a 58-hour or a 60-hour schedule. The average reduction was, therefore, over four hours per week as compared with a reduction of two hours or less for the three mills in this group which maintained production.

The 54-hour group included 7,500 workers, or about one-fifth of the total number covered by the report; approximately 2,100 were in mills reporting output maintained, against 5,400 in establishments reporting output decreased. The three establishments maintaining output, as well as the eight reporting a decrease, include throwing mills in the processes of which machinery dominates production. It should be pointed out, however, that in those establishments which maintained output the throwing was done in combination with other processes where handwork plays a more important part. For mills doing throwing exclusively, there is evidence that a 54-hour week will not maintain production as against a somewhat longer schedule. The evidence for the whole group indicates that a 54-hour schedule did not maintain maximum output, but the basis of experience is so limited and the qualifications and collateral conditions so varied that this cannot be stated as a positive conclusion.

THE 55-HOUR GROUP

In the 55-hour group, three mills maintained output and six reported a decrease; all were small establishments, together employing less than 4% of the total number of workers covered by the table. In one establishment it was stated that maintenance of output was due to the inauguration of a bonus system and not to the reduction in time. In another case it was stated that a throwing mill which maintained output had reduced hours some fifteen years ago, since which time important changes have taken place in the throwing industry. The weight of the evidence, though again limited, indicates that maximum output was not maintained with a 55-hour week.

FACTORS BEARING ON EFFICIENCY

The preceding discussion shows that results of reductions in hours-of-work schedules in the silk industry varied widely in different establishments. An important fact is that such differences are found in the case of each different weekly schedule. This means, of course, that changes in the length of the workday are not the only factor affecting output. It becomes necessary, therefore, to examine some of the other factors in the problem such as the character of the product, the size of the establishment, changes in wages, efficiency of management and the relative importance of machine and handwork.

The character of the product apparently did not have a controlling influence on output with the possible exception of those processes which, like throwing, are largely dominated by machinery. In respect to finished goods, it appears that both the group of mills maintaining production and the group reporting output as decreased covered a considerable variety of product.

Similarly, ability to maintain production when hours were reduced does not appear to depend on the location or the size of the establishment. Some large plants reported decreases while others reported that output was maintained. Very small plants and those of moderate size likewise are found in each group.

Again, changes in output are not attributable to changes in rates of wages. In a great majority of establishments reporting on this point, piece rates or hourly rates of wages were substantially increased when hours were reduced, but results on the whole were not significantly different than for those establishments in which rates remained unchanged.

In some cases the payment of a bonus tended to increase the efficiency of workers but there is not a sufficient basis of experience to warrant conclusions on this point.

Differences in output results among different establishments, when hours of work were shortened, are undoubtedly explained in part by differences in the efficiency of management. In this respect, there is, of course, a wide range. Under any given schedule of hours it will be found that some establishments will fail to secure the results obtained by others. It does not necessarily follow that the establishments which do not maintain production are less efficient than those maintaining output, since the character of the process, the class of employees, the raw material, or numerous other factors may have had an important bearing. Comparison of the efficiency of different mills is every difficult. But that variations in the efficiency of management are bound to have an important influence on the ability of different establishments to maintain production under any given schedule of hours is indisputable.

It is, however, of secondary interest to explain the differences in results in different establishments. The important question to determine, especially in view of the general failure of cotton and wool manufacturing establishments to maintain output on even a 54-hour schedule, is how some silk establishments are able to accomplish this with a still shorter week.

The principal reason apparently is to be found in the greater importance of hand-time work in silk manufacturing with the consequently greater opportunity for increasing the efficiency of the individual worker. Silk machinery is, on the whole, less automatic than wool-mill equipment, and very much less automatic than cotton machinery.

In this connection an official of a large silk establishment said:

> The cotton loom running on good work practically runs all day long without any warp breakage, and all that is necessary is to keep changing the shuttles, so that it is practically

> all machine work and very little hand-time work for the weaver. On silk looms, warp breakage is very much greater and, of course, varies according to the work that is being done, but on a general average a weaver loses one-third of his time repairing broken threads or other disturbances in the warp. This so-called hand-time work, of course, may vary among the various weavers, depending on their ability and dexterity.
>
> If thirty-three per cent (33%) of a weaver's time is spent on handwork, in a shorter hours-of-work period the energy may be sufficiently increased and the fatigue sufficiently decreased to permit a weaver to produce as much in nine hours as he formerly did in ten.[1]
>
> The energy of a weaver and power of work may vary according to the hours of work, the longer the hours, the more the loss of energy and power to work towards the end of the day, or in other words, the loss caused by fatigue.
>
> This is also the case throughout most of our operations requiring a lot of handwork, and we find that people can practically deliver in nine hours the same amount of work as done before in ten, whereas, where the operation is more or less automatic, the loss in production is proportionate to the loss in time.

Another large manufacturer said, in substance:

> The ability of a worker to maintain output on a 50-hour schedule as against a 55-hour schedule varies with the amount of handwork. This is not an ironclad rule but I can safely say that, throughout our mills, in those departments where machine work controls to a high degree, output has fallen about proportionally to the reduction in time. On the other hand our experience has been that in processes where handwork controls there has been a gain in efficiency in some cases sufficient to offset the loss of time at the worker's disposal. Between these limits there are various sets of conditions, but the fact seems to be that the ability to increase hourly efficiency grows less as the part a machine plays in any task increases. In spinning, the machine almost controls output. Machines are less the master in dyeing and weaving but even there the machines largely dominate. In contrast with these processes we have the opposite extremes where handwork controls, such, for example, as sorting materials, trimming, inspection, cutting and folding.

In line with these opinions is the statement of another silk manufacturer submitted to a committee of Congress in connection with tariff discussion.[2] He said in part:

[1] This statement refers to a reduction from a 55-hour to a 50-hour week.

[2] U. S. Tariff Commission — Tariff Information Series No. 3. Schedule L. Statement of Mr. Horace B. Cheney.

> The hands of the silk worker are one of his most important assets. Take a man from the fields of Siberia, from the plains of Austria, from Southern Italy, or from a farm in the United States or Sweden — and that is about the conglomeration we get in this country — and it is a different matter to make a silk worker of that man, a very different matter, from taking men who have been brought up in countries where silk is produced, where the very habits and occupations have developed the technique and the kind of hand that makes the silk worker. They work to better advantage with it. Machinery does not do away with the use of hands in silk manufacture. The hands still remain, and will always remain, in my opinion, a very important factor in the operation. A man with clumsy, awkward hands handling silk warp is a very different factor from the man whose grandfather before him handled the silk fabric.

From the statements just given, it is clear that many operations in silk manufacture involve much hand-time work in which the quality and quantity of the product turned out depend to a considerable extent on the skill of the individual worker. There can be no doubt that this fact explains in part the ability of some silk establishments to maintain production on a schedule of hours much shorter than is practicable in either the cotton or wool manufacturing industries.

If machinery always ran at a uniform speed without stoppage during each spell of the workday, a maximum of efficiency would be attained. That is, actual production would coincide with the theoretical maximum of 100%. If the machinery were stopped for 25% of the time, there would be a 25% loss in production. Similarly, the effect of a 25% reduction in work-hours, unless offset by an increase in the efficiency of the operative, would be to bring a corresponding loss in output. Where the speed or type of machinery cannot be improved under such reductions in hours, a loss in output is unavoidable in processes where the machine dominates, unless it is possible to increase the efficiency of the operative. Conversely, there is more opportunity to offset a reduction in the work schedule where handwork is an important factor. For instance, in cotton spinning, handwork represents only a small part of the process, perhaps not more than 5%. If machine time is reduced 20% by a reduction in the hours of work, and there is no opportunity to increase the speed of the machinery, it becomes almost impossible for the operative to increase his own efficiency to an extent which will fully offset the loss in machine time. The same principle holds generally true in the case of silk throwing although the element of handwork here is rather greater than in the case of cotton spinning. For this reason it is exceedingly difficult for silk mills exclusively engaged in throwing processes to maintain production when hours of work are shortened below 54 or 56 per week.

In the case of weaving, however, and in some other processes in silk manufacture, the operative has much greater opportunity to increase personal efficiency. Thus weavers must be on the alert for many troubles. Among these may be mentioned the following: twisting and sticking of yarn at the cross-rods; unequal running of the loom and variations in the harness due to extremes of heat and moisture in the weave room; imperfections in the fabric due to damaged reeds and worn blades; spotting of goods due to improper oiling; spotting or streaking due to loose particles from dirty harness or machinery; streaks due to badly drawn ends in the harness or crossed in the reed; imperfections caused by too many knots (smashes); imperfections in the fabric due to looms working irregularly or out of time; broken picks in filling resulting from improper functioning of the stop motion device.

The extent to which the machine dominates cannot be determined from cursory observation. Some processes which seem almost automatic really involve a considerable amount of hand-time work.

MACHINE EFFICIENCY

Some mills reporting for this investigation stated that they were able to increase the hourly efficiency of their workers by installing improved machinery and by increasing machine speeds. These changes in a few cases appear to have been sufficient to offset a substantial reduction in working time. In many establishments, however, a high state of machine efficiency had been attained prior to the latest reduction in hours. It is clear that neither the installation of new machinery nor the increase of speeds is a factor the beneficial effects of which should be attributed to the shortening of the work-week, except in cases where the new machinery or the increased speed involved such extra strain on the part of the workers that a longer work schedule would not have been practicable. If, however, a reduction in the hours of work permits an increase in the speed of machinery beyond a point which would be practicable under a longer schedule of hours, this gain is fairly to be used as an argument in favor of the shorter work-week. But if speed of machinery could have been increased under the longer week without increasing the operatives' fatigue, a reduction of hours means a relative loss in production even though actual production may be as great as before.

By the use of electric power and especially by means of the individual motor drive, some establishments have been able to speed up production. There always are, however, speed-limiting features, such as the quality of the material used. Thus both the quantity and quality of yarn production is affected by the quality of raw silk and silk waste, while loom production is in turn affected by the quality of the yarn.

On the whole, it appears that improvements in machinery or increases in speed of machinery were not an important factor in the output comparisons presented in this report.

RELATIVE EFFICIENCY OF PIECEWORK AND DAYWORK

As in the case of the other industries thus far investigated, considerable evidence was obtained to the effect that the piece-rate system was more conducive to the maintenance of output with shorter hours than was the day-rate system. Thus, the appendix table occasionally contains such statements as the following by manufacturers reducing to a 50-hour schedule from a longer week:

> Same output for daywork; 10% increase in output for piecework.
>
> Pieceworkers speeded up and there was no loss of production; dayworkers did not speed up, with consequent loss of 8 to 10% in production.
>
> Total output decreased 3 to 6% for piecework and 10% for daywork.

These statements are by no means typical, since in many cases the output of pieceworkers was reduced practically as much as that of dayworkers. Nevertheless, these statements indicate rather definitely that it is more practicable to maintain production under the piece-rate system than under the day-rate system, when hours are shortened. While the statements of manufacturers indicate that in a few cases time-workers made some improvement in hourly efficiency, this improvement, as a rule, was too slight to offset the reduction in hours, and in some cases there was a decrease in even the hourly efficiency, which would mean that the reduction in total output was more than proportional to the reduction in hours.

The result was that in a great majority of cases the output of the mill as a whole showed a loss.

In connection with the relative efficiency of piece and time work, the following statement by an executive of a large mill is of interest:

> When we . . . run on short time . . . all the piecework operatives endeavor to make the same wages in less time, with the result that our hourly production is materially increased. This has led to the belief that if we operated short hours but paid full wages for the shorter hours, we would not get increased production per hour to amount to enough to make up for the increased wages.
>
> Our operatives wish to make about a certain amount a week. If we pay that amount for slack work, they have no incentive to do good work.

In estimating the influence of the piece-rate system it must be remembered, however, that differences in personal efficiency may result from other factors, such as age, temperament, and general physical and mental fitness.[1]

---

[1] The Board's report on the wool industry mentioned certain reasons why one weaver may make a better output showing than another. These apply with equal if not greater force to silk weaving and are as follows in substance:

1. Differences in the warp.
2. One weaver may tie ends or change shuttles more quickly than another.
3. When the material is not woven properly the weaver must pick out and pull the beam back, and get the proper tension — otherwise there will be thick or thin places. One weaver may perform these operations more quickly and more skillfully than another.
4. Variations in the complexity of the weave may be more easily adopted by one weaver than another; one will seize the idea of the new weave boldly, while another will lack confidence.
5. The watchful weaver catches the shuttle when there are a few more winds of yarn on the bobbin, and in this way avoids the work of finding the piece of thread and closing the gap; another may be too late for this.
6. Correcting defects in complex weaves requires judgment and skill. Weavers show considerable difference in this respect.

From the general evidence here reviewed it appears, therefore, that in a majority of establishments reporting, output was not maintained with a 50-hour weekly schedule. Nevertheless, maintenance of output or an improvement in hourly efficiency was reported in a sufficient number of cases to fairly raise the question whether, with efficient management and good quality of material, such a schedule or a schedule not much in excess of 50 hours might not be a reasonably practicable one for the industry. Before reaching final conclusions, it is desirable to analyze certain statistical evidence of a more detailed character obtained from several establishments during the course of the investigation.

STATISTICAL DATA AS TO OUTPUT

DIFFICULTIES OF SECURING COMPARABLE DATA

The factors influencing efficiency of operation are so numerous that the effect of any single factor, such as a change in the length of the workday, can be measured in only an approximate way. By its very nature the problem is one which does not lend itself to refined calculations. The essential thing to determine, however, so far as output is concerned, is whether a given change in the length of the workday resulted in a change in the total production, and in case of a decrease, whether that decrease was important or negligible. For this purpose the collective experience of a substantial number of establishments permits of conclusions which, though broad, are nevertheless valid.

Some of the difficulties involved in a statistical comparison of output under different hours-of-work schedules have already been set forth in previous reports on experience in the cotton and wool manufacturing industries and in the boot and shoe industry.[1] Thus differences in the weight, quality, and texture of the fabric all have an important bearing. Again, the great variety of weaves or patterns for which the silk industry is noted introduces difficulties, since complicated patterns generally require more attention and skill on the part of the weaver, or possibly a slower speed of the loom, than do plain fabrics or fabrics of comparatively simple pattern. Still again, many silk establishments produce a wide variety of fabrics ranging all the way from ribbons to dress goods. Unless output comparisons under different schedules of hours are confined to goods of substantially similar patterns, or to a variety of fabrics the proportions of which are fairly constant, the result may be misleading.

The delicacy of the silk fiber introduces a still further difficulty into statistical measurements. Because of its extraordinary fineness, relatively small differences in sizes of yarn may have an important effect on the total quantity of the finished fabric. The quality of the fiber is equally important. Fiber of poor quality is a source of frequent breakage of yarn, with consequent loss of time of the operative in repairing broken ends.

---

[1] National Industrial Conference Board: Research Reports Nos. 4, 7, and 12.

Owing to differences in climatic conditions while the worms are being reared, to differences in the care with which the raw silk is prepared, and to various other causes, the quality of silk fiber varies greatly in different years.

During the war some inferior silk fiber which formerly went to other countries was brought into the United States. On the other hand, the quality of the fiber of the 1917 crop was unusually good. On the whole, American silk establishments have in recent years endeavored to secure a better grade of raw silk than that formerly used. Over any considerable period of time these variations in the quality of the raw material might be sufficient to invalidate output comparisons, although they are not an important factor in the comparisons presented in this report, which are for periods shortly before and shortly after a reduction in hours.

The difficulties noted, which by no means exhaust the list of complicating factors, necessarily qualify conclusions as to the statistical evidence presented in this chapter, and indeed forbid as definite conclusions as were reached in the corresponding studies of output in the cotton and wool manufacturing industries. Nevertheless, the material here assembled gives a somewhat broader basis for conclusions than that obtained from the data already given, and, if used with due recognition of such collateral factors as those just mentioned, is of decided value.

Figures of production based on book records were obtained from 10 establishments representing various major establishments of the industry.

It will be noted that, in several cases, the production per loom per week is given as the "indicated" production. In such cases, this figure has been arrived at by first determining the actual production per loom per *hour*, based on the actual number of hours worked and the actual number of looms in operation, and then applying this average per loom per hour to the nominal number of schedule hours per week. This basis of comparison gives an accurate idea of the efficiency of the two different hours-of-work schedules, where the actual hours worked show only a small variation from the nominal factory hours.

COMPARISON OF OUTPUT OF A LARGE BROAD-SILK MILL

A modern mill operating about 1,000 broad looms and employing approximately 600 workers furnished the comparison given below. The mill is located in a large industrial center.

TABLE 6: COMPARISON OF WEEKLY OUTPUT OF A BROAD-SILK MILL FOR 10 WEEKS UNDER A 55-HOUR SCHEDULE WITH THAT FOR AN 11-WEEKS PERIOD UNDER A 50-HOUR SCHEDULE

Period	Hours per week	Production: per week per loom: yards
1916		
January–April, 10 weeks	55	94.9
April–June, 11 weeks	50	86.3

9.1% reduction in hours per week.
9.1% reduction in yards per loom per week.

For the 50-hour week the loss in production as compared with the 55-hour week was therefore proportional to the reduction in time. The wage rates of weavers were advanced 20% at the time of the change in hours. There were certain interruptions in the work in both periods, for which, however, adjustment was made. There seems little reason to doubt that the reduction in time was largely responsible for the decrease in output.

The weekly production per loom at this plant for the two periods was as follows:

FIRST PERIOD

Week Ending		Looms	Product per Loom (yards)
Jan.	17th	962	87.7
	24th	964	85.3
	31st	978	98.3
Feb.	7th	979	98.1
	14th	975 (*a*)	93.3
	21st	974	93.6
	28th	978 (*b*)	89.8
March	6th	969	95.7
	13th	978	96.6
	20th	977	99.3
	27th	978	95.4
April	3d	979	98.5
Average yards per week per loom			94.9

SECOND PERIOD

Week Ending		Looms	Product per Loom (yards)
April	10th	983	92.2
	17th	972	85.0
	24th	974	87.5
May	1st	976	82.1
	8th	977	92.6
	15th	958	91.0
	22d	978	84.7
	29th	977	86.6
June	5th	977 (*c*)	69.3
	12th	976	81.6
	19th	989	87.6
	26th	977	78.9
Average yards per week per loom			86.3

(*a*) 5 hours lost. (*b*) 10 hours lost. (*c*) 10 hours lost.
These broken weeks are not included in the averages.

This table brings out very clearly a fact which should always be kept in mind in comparing production under different hours-of-work schedules, namely, that even under the same weekly hours of work there will be considerable fluctuation in the output from week to week, although perhaps not so marked as shown in this instance, where the mill was making a variety of fabrics. For this reason it is unsafe to draw conclusions from the experience of a single week, although collectively even such limited experience may be of value. In averaging results over a period of several weeks, however, such inconsistencies tend to counterbalance each other and give a fair indication of the real effect of the change in hours on output.

It will be noted that there were two broken weeks in the first period and one in the second period. In the first period under the longer schedule this broken time had much less effect on the weekly output than in the second period. These broken weeks are not included in the averages.

Comparison of Output of a Velvet Mill

Table 7 presents a comparison based on data furnished by a large velvet mill which reduced hours from 55 to 50 per week in 1916.

TABLE 7: COMPARISON OF WEEKLY OUTPUT OF A LARGE VELVET MILL FOR TWO 10-WEEK PERIODS UNDER A 55-HOUR AND A 50-HOUR SCHEDULE RESPECTIVELY

Period	Hours per week	Average weekly production per weaver: yards
1916		
10 weeks previous to June 16	55	306.0
10 weeks after June 16	50	280.7

In this case a reduction of 9.1% in time was accompanied by a loss of 8% in output per weaver. A comparison for the same number of looms showed a decrease in the weekly production per loom of 5.6%.

The management stated that the mill was operated to full capacity in each period on a product of uniform character and that conditions were unusually favorable for a fair comparison. There is, therefore, little doubt that the reduction in hours was chiefly responsible for the decrease in output.

In the manufacture of velvets quality is a prime consideration and speed of machinery cannot easily be increased. For the same reason it is less practicable to increase the speed of handwork. Therefore, the element of machine time is the dominant factor, with the result that the loss in output was very nearly proportional to the reduction in hours.

In a prior reduction from 60 to 55 hours per week in this plant in 1915, by the adoption of a Saturday half holiday, a loss of 16% in production was shown. This loss is so marked as to indicate that some other factor than the shortening of hours was also involved.

In the reduction from 60 to 55 hours per week as well as that from 55 to 50 hours, there was a slightly greater output per weaver per hour during the first five weeks than during the second five weeks after the change in hours. This indicates a temporary increase in efficiency due to speeding up directly after the reduction in hours and a subsequent relapse into a slower settled speed. Similar experience, it may be noted, was reported by a number of establishments in other industries investigated as well as in the silk industry.

COMPARISON OF OUTPUT OF A BROAD–SILK MILL

A broad-silk mill which reduced hours in 1916 from 55 to 50 per week submitted the comparison given in Table 8 for a period of 6 weeks under a 55-hour schedule and for a 6-week period under a 50-hour schedule. The management stated that conditions were on the whole such as to permit of a fairly accurate comparison.

The mill is located in an important silk manufacturing center and operates both ordinary broad-silk looms and Jacquards.

TABLE 8: COMPARISON OF WEEKLY OUTPUT OF A BROAD-SILK MILL FOR A 6-WEEK PERIOD UNDER A 55-HOUR SCHEDULE WITH THAT FOR A 6-WEEK PERIOD UNDER A 50-HOUR SCHEDULE

Period	Hours per week	Number of looms	Actual yards per hour per loom
1916			
Two weeks ending February 23	55	106	1.015
" " " March 8	55	105	1.091
" " " March 22	55	107	1.088
Average			1.065
" " " April 19	50	103	1.169
" " " May 3	50	102	1.100
" " " May 17	50	112	1.161
Average			1.143

9.1% reduction in hours per week. Loom hours, first period, 33,390.
2.4% indicated loss in yards per loom per week. Loom hours, second period, 31,700.

This shows that reduction of 9.1% in working time was accompanied by an increase of 7.3% in hourly output. While this was not sufficient to offset the reduction in hours, the indicated loss in total output was only 2.4%.

Ordinarily interruptions resulting from colds and other sickness are more common in February and March than in April and May. It is possible that the gain in hourly efficiency shown for the 50-hour period may have been in part due to the more favorable weather. As stated, however, it is the opinion of the management that the comparison gives a fair representation of the output effects of shortening the work-week.

COMPARISON OF OUTPUT OF A BROAD-SILK MILL

The comparison given in Table 9 is for a large broad-silk mill located in a silk manufacturing center. The product is mostly fancy tie silks varying from 76 to 180 picks per inch; there was also considerable variation in the width of the goods produced. The output of the periods given below were regarded by the management as being, on the whole, fairly comparable.

TABLE 9: COMPARISON OF WEEKLY OUTPUT OF A BROAD-SILK MILL FOR THREE MONTHS UNDER A 55-HOUR SCHEDULE WITH THAT FOR THREE MONTHS UNDER A 50-HOUR SCHEDULE

Period	Hours per week	Number of looms	Indicated production per week per loom: yards
1916			
January	55	180	71.88
February	55	180	76.12
March	55	196	73.48
Average			73.83
April	50	220	63.50
May	50	224	71.90
June	50	224	68.35
Average			67.92

9.1% indicated reduction in time
8.0% reduction in output

The loss in production in this case was nearly proportional to the reduction in time. There were several collateral factors which qualify the statistical data. Thus good weavers were scarce at the time hours were reduced and efficiency suffered somewhat during April, May, and June; moreover, the attendance of the weavers was not quite as regular during those months. Again, rates of wages were advanced 10%, and this may have influenced production somewhat. In the opinion of the management, these collateral factors had only a minor bearing and the greater part of the decrease in production was attributed to the shortening of the workday.

COMPARISON OF OUTPUT OF A BROAD-SILK MILL

The comparison given in Table 10 is for a large broad-silk mill which reduced hours from 55 to 50 per week in 1916. It is located in a silk center and produces chiefly dress and tie silks.

TABLE 10: COMPARISON OF WEEKLY OUTPUT OF A BROAD-SILK MILL FOR TWO MONTHS UNDER A 55-HOUR SCHEDULE AND FOR THREE MONTHS UNDER A 50-HOUR SCHEDULE

Period	Hours per week	Looms	Indicated production per week per loom: yards
1916			
February	55	265	61.05
March	55	270	59.40
Average			60.23
May	50	278	60.90
June	50	277	52.90
July	50	283	60.20
Average			58.00

The 9.1% reduction in working time at this mill was accompanied by a 3.7% loss in output. It will be noted that there was a marked increase in hourly efficiency, although not sufficient to offset the shortening of hours. However, omitting the figures for June, which obviously are not fully comparable, the weekly production showed a slight increase under the shorter schedule.

The preceding comparison is for the output of the entire mill. For a portion of the looms running on the same quality of goods the comparison was distinctly in favor of the 50-hour week, as the following table shows:

Production: Same Quality of Goods

Period	Hours per week	Looms	Actual production per loom hour: yards	Indicated production per loom per week: yards
1916				
March	55	27	.861	47.36
April	50	34	.956	47.80
June	50	47	1.020	51.00

For these goods, therefore, the June production per loom under a 50-hour schedule showed a gain of 7.7% over that in March with a 55-hour schedule. Allowing for the fact that efficiency of operation is usually greater in periods of full demand than when work is running light the comparison still suggests a decided gain in efficiency under the shorter schedule. The increase in hourly efficiency (18½%) was, however, so great as to leave no doubt that other factors than the shortening of the workday contributed to the result.

COMPARISON OF OUTPUT OF A THROWING MILL

The throwing department of a mill which reduced its working time in 1917 from 54 to 50 hours per week furnished the following comparison:

TABLE II: COMPARISON OF WEEKLY OUTPUT OF A THROWING MILL FOR SIX MONTHS UNDER A 54-HOUR SCHEDULE WITH THAT FOR A SIMILAR PERIOD UNDER A 50-HOUR SCHEDULE

Period	Hours per week	Average monthly amount of silk thrown: pounds	Average per throwing employee: pounds
1917			
Six months previous to May . . .	54	4,800	120.0
Six months after May	50	4,965	110.3

In this case the reduction of 7.4% in work-hours was accompanied by a loss of 8.1% in output. As already explained, the throwing process is one in which machinery dominates to an unusual degree, making it correspondingly difficult for the operative to offset a reduction in work-hours.

This mill is located in an industrial center, although little silk manufacturing is done in its vicinity. An executive stated that its schedule of hours was reduced to 50 per week in order to prevent the establishment's best operatives from going into other lines of work where hours were below 54 per week. In the opinion of the management the comparison given above fairly shows the results of the reduction in hours in this department.

A marked increase in average weekly production in this establishment which occurred between 1912 and 1917 was reported as having been largely due to a change from day-work to piecework and to the installation of improved machinery.

OTHER COMPARISONS

Several other statistical comparisons were secured in the course of the investigation.

A comparison for a weaving mill making broad silks, located near an industrial center, which changed its work-week from 55 hours to 50 hours in April, 1916, is given below; all looms were run at the same speed, each weaver operating three looms.

Period	Hours per week	Number of looms	Production per week per loom: yards
1916			
March 14–28	55	110	162.05
April 11–25	50	122	156.31

This shows a 3.5% decrease in output per loom per week accompanying a reduction of 9.1% in time. There was, therefore, a marked increase in hourly efficiency.

A comparison of output of a broad-silk mill for one week in March, 1916, under a 55-hour schedule with that for a week in April of the same year under a 50-hour schedule showed a loss of only 1.2% in production per loom; the reduction in time was 9.1%. A week is too short a period to warrant final conclusions. In this case, however, it was specifically stated by the management that the weeks were representative and the opinion was furthermore expressed that under the shorter schedule there was a noticeable increase in personal efficiency of the workers. It may be noted that it was the opinion of the management that, in this general section, arbitrary restrictions of output were commonly practised.

Another mill making broad silks and ribbons in April, 1916, reduced hours from 55 to 50 per week with an immediate output loss of 5%. A later comparison showed a 7½% loss. The management stated that the reduction in working time was unquestionably the cause of the marked decrease in output, though there was some increase in hourly efficiency.

The statistical evidence thus gathered is summarized in the following table. The reductions in hours were made in 1916, with one exception:

TABLE 12: SUMMARY OF OUTPUT DATA COVERING REDUCTIONS IN TEN ESTABLISHMENTS FROM A 55 TO A 50-HOUR WEEK

Kind of Mill	Percent decrease in weekly output per loom	Change in *hourly* efficiency
Weaving: Broad	1.2%	Increase
Weaving: Broad and Jacquards	2.4%	Increase
Weaving: Broad	3.5%	Increase
Weaving: Broad, all looms	3.7%	Increase
Looms on one class of goods	_*7.7%_	Marked increase
Weaving: Broad and narrow	7.5%	Increase
Weaving: Broad	8.0%	Increase
Weaving: Velvet (*a*)	8.0%	Increase
Weaving: Broad	9.1%	Unchanged
Throwing (*b*)	8.1%	Decrease

Where hourly efficiency is merely maintained the total weekly output is decreased about in proportion to the reduction in hours.

---

*Increase in italics.

(*a*) Per weaver.

(*b*) Per throwing operative. In this mill previous hours were 54 per week, making the percentage of lost time 7.4 instead of 9.1, as in the other mills of this group. The reduction was made in 1917.

These various comparisons are on their face conflicting. Nevertheless, two facts are definitely established. First, there was in a majority of cases some loss in output and, in processes where machinery dominated to an unusual degree, a practically proportional loss. Second, in a majority of instances there was some increase in hourly efficiency and in certain cases a decided increase.

The results of this statistical analysis are, therefore, in substantial harmony with those presented in the preceding chapter, based on evidence of a more general character.

CONCLUSIONS AS TO OUTPUT

The experience with a 50-hour week in the silk industry presented in the preceding discussion shows clearly that such a schedule has, in a great majority of instances, been accompanied by a loss in output. For 58 establishments reporting results secured with such a work-week, only 9 maintained the production previously secured with longer schedules; in 2 of these 9 establishments there was an increase. On the other hand, 23 establishments, employing more than one-half of the total workers included in the 50-hour group, reported a loss in output somewhat less than proportional to the reduction in hours. Only one establishment reported a loss more than proportional to the reduction in time. In 19 establishments, or about one-third the total number, the loss was reported as about proportional. These facts are presented in the following summary for the 50-hour group:

50-Hour Group	Establishments	Percent of Total Employees in Group
Establishments reporting output increased . . .	2	1.6
Establishments reporting output maintained . . .	7	15.0
Establishments reporting a decrease in output less than proportional to the reduction in hours . .	23	52.0
Establishments reporting a decrease in output about proportional to the reduction in hours . .	19	21.0
Establishment reporting a decrease in output greater than proportional to the reduction in hours	1	1.8
Establishments reporting a decrease in output but not stating its amount	6	8.6
	58	100.0

This statistical evidence, in connection with the statements of employers given in the text and in the appendix, indicates that the point of maximum output in the silk manufacturing industry as a whole lies somewhere between 50 and 54 hours per week. Because of the limited experience available with intermediate work schedules it is impossible to fix that point definitely. The point of maximum production, moreover, is not the same for all classes of mills. In processes where machinery dominates to an exceptional degree as, for instance, in throwing or in certain kinds of weaving, reduction of work-hours to even 54 per week has usually involved some loss in output.

But, taking the industry as a whole, it may fairly be concluded that the point of maximum production is somewhat nearer 50 hours than 54 hours per week.

This conclusion is in sharp contrast with that reached in a similar study of the cotton manufacturing and wool manufacturing industries. In the latter, output was not maintained on a schedule of 54 hours per week; while in the cotton industry, reductions to even a 56-hour week almost invariably involved a loss in production. The reason for this difference in results is largely to be found in the much greater importance of skilled handwork in the manufacture of silk goods, which affords a correspondingly greater opportunity for the worker by his own effort to influence efficiency of production.

HEALTH OF SILK-MILL WORKERS

The same difficulties that were experienced in attempts to determine the relation between hours of work and health of workers in the cotton and wool manufacturing industries were also encountered in the study of the silk industry. Practically no records covering a sufficient period to permit of satisfactory study were available, while the absence of any definitely recognized standard for the measurement of health conditions, and above all the great number of factors entering into the problem, made it difficult to draw conclusions from such general statements as were secured.[1] It is, for instance, obvious that such influences as nationality, inheritance, personal hygiene and habits have a very important bearing on health, so that even though a change in hours of work may have a significant effect, this may be overshadowed by the collective effect of other factors.

Six establishments reported an appreciable improvement in health of workers with a 50-hour schedule, as compared with conditions obtaining under a longer week. In one of these a marked lessening of fatigue was reported. A large majority of the establishments covered by the investigation, however, reported that they observed no noticeable change in health conditions when hours were shortened to 50, 52, or 54 hours per week from longer schedules.

A representative of a large silk manufacturing establishment conducting practically all branches of the industry stated:

> The results of our Benefit Society for the periods covered by days of different working hours appear to show an improvement in health with shorter hours. We doubt very much whether this can be so simply disposed of, as there are many other factors that enter into it. The most important is that in the beginning the Benefit Society took into membership anybody regardless of his physical condition, but the fifty-hour period has been upon the basis of a physical examination and all undesirable risks have been rejected; also during both the fifty-five and fifty-hour period, there has been medical

---

[1] Some of these factors are noted in Research Report No. 4, Hours of Work as Related to Output and Health of Workers — Cotton Manufacturing.

> supervision, free medical advice and treatment for all people who are at work. Therefore, it probably will be unsafe to draw any conclusions from these figures as to the effect of working hours upon the health.

General factory conditions in the silk industry compare favorably with those in other leading branches of the textile industries. The value and delicacy of the product make cleanliness almost imperative. Good lighting, likewise, is essential. There is, furthermore, comparative freedom from dust, which is a source of considerable trouble in both the cotton and wool industries. Thus, the report of the United States Bureau of Labor Statistics on Women and Children Wage-Earners in the United States, said:[1]

> A silk mill is, as a rule, clean. There is no dust or lint or fumes in the air, so the need for special means of ventilation is not so imperative as in other textile mills. . . . The manufacture of silk requires that it should be conducted in well-lighted and clean rooms. Silk thread must be watched carefully as it is being wound or spun or woven in order to detect broken or knotted threads. The best lighting facilities are therefore necessary and are in a great majority of cases provided. The mills are constructed with the plan of providing the greatest possible amount of natural light.

On the other hand the report just cited contained considerable criticism of improper ventilation. This was attributed, not to lack of sufficient air space, but to failure to keep a sufficient number of windows open. This criticism applied to conditions as they existed several years ago. Faulty ventilation was also observed in a few of the mills visited by representatives of the Conference Board in the course of its investigation. In the larger establishments, however, ventilation was not only good but often almost ideal. In this connection it should be pointed out that many small silk establishments conducting a few specialized processes rent space in a building where power may be purchased. In such cases, there is more likelihood of overcrowding than in larger establishments conducting more processes of manufacture.

GENERAL HEALTH CONDITIONS IN THE INDUSTRY

With the exception of tuberculosis, the silk industry makes a favorable comparison with other leading textile industries from the standpoint of health. Statements of manufacturers furnished in this investigation indicated generally favorable conditions of health among their employees. Frequently these conditions were reported as excellent and almost never as distinctly unfavorable.

---

[1] U.S. Senate. 61st Congress, 2d Session, Document 645.

The silk industry is, however, characterized by a distinctly high death rate from tuberculosis. This is clearly brought out in Table 13 compiled from data collected in the Census of 1909.

TABLE 13: PERCENTAGE OF DEATHS OF MALES AND FEMALES DUE TO TUBERCULOSIS, OF THE TOTAL MORTALITY FOR THE SILK, WOOL, AND COTTON INDUSTRIES AND FOR ALL MANUFACTURING AND MECHANICAL PURSUITS, BY AGE GROUPS

(U. S. Census Mortality Statistics, 1909)

Age Group	Males				Females			
	Silk	Wool	Cotton	All Mfg. and Mech. Pursuits	Silk	Wool	Cotton	All Mfg. and Mech. Pursuits
All ages 10 and over	19.8	22.3	21.1	15.5	37.7	29.3	29.7	27.4
15 to 19	27.7	30.8	19.6	22.1	38.8	36.8	38.2	37.9
20 to 24	50.0	44.8	48.8	32.5	53.4	51.6	50.9	44.4
25 to 34	29.8	41.7	37.8	30.8	46.7	42.3	35.6	40.8
35 to 44	28.5	35.3	27.1	25.0	30.0	20.0	32.2	26.3
45 to 54	13.3	16.7	19.4	15.6	22.2	11.8	14.9	12.3
55 to 64	7.0	13.6	9.4	8.2	20.0	5.9	9.1	9.3

As compared with the average mortality for all manufacturing and mechanical pursuits, this table shows a distinctly high death rate from tuberculosis for silk-mill operatives. Furthermore, it is higher for female workers, who constitute considerably more than half the total work-force of the average silk mill, than for males.[1]

A similarly high death rate is shown by more limited data based on the industrial experience of the Prudential Insurance Company during the period 1897 to 1900 inclusive.[2] In these four years there were 142 deaths of silk workers among males included in the industrial experience of the above named company. The following table shows the percentage distribution of these deaths by principal causes, and also gives corresponding percentages for the same causes for 79 selected occupations.

---

[1] It should be borne in mind that the census data give only the occupations followed at the time of death. It does not necessarily follow that the occupation reported for the worker at the time of death was followed by him during the greater part of his working life, or that the disease causing death was contracted while he was engaged in his last occupation.

[2] This Prudential Insurance Company material was furnished through the courtesy of Dr. Frederick L. Hoffman, Third Vice President and Statistician.

TABLE 14: PERCENTAGES OF DEATHS OF MALE SILK-WORKERS FROM CERTAIN CAUSES, 1897 TO 1900, COMPARED WITH SIMILAR PERCENTAGES FOR 79 SELECTED OCCUPATIONS, AS SHOWN BY THE INDUSTRIAL EXPERIENCE OF THE PRUDENTIAL INSURANCE COMPANY

	Silk Workers		79 Occupations
Causes	Number of Deaths	Percent of Total	Percent of Total
Total	142	100.0	100.0
Typhoid	11	7.8	2.7
Alcoholism	1	0.7	0.9
Tubercular Diseases	55	38.8	23.0
Nervous Diseases	7	4.9	11.4
Circulatory Diseases	10	7.0	9.4
Respiratory Diseases	17	12.0	14.9
Liver Diseases	4	2.8	2.7
Other Digestive Diseases	4	2.8	4.9
Urinary Diseases	12	8.5	10.1
Accidents	6	4.2	8.0
Suicide	2	1.4	1.9
Other Causes	13	9.1	10.1

While for several of the causes listed in the above table the number of deaths is so small that the percentages must be used with great caution, the comparison as a whole brings out strikingly the decided preponderance of tubercular and respiratory diseases as causes of death among this group of male silk-workers. Thus, nearly 39% of the total was attributed to tubercular diseases and an additional 12% to respiratory diseases. The percentage of deaths from tubercular diseases, it will be noted, was distinctly higher than the average for the 79 selected occupations.

With the exception of tubercular diseases and typhoid fever, for which the high death rate among these silk workers apparently reflected local conditions in Paterson, the percentages of deaths due to the specific causes mentioned were as a rule lower for silk workers, and frequently decidedly lower, than the corresponding averages for the 79 selected occupations.

It may be considered as established that the death rate from tuberculosis among silk-mill operatives is distinctly high as compared with the average rate for factory industries in general. There is a strong presumption, moreover, that conditions in the industry itself are partly responsible, although these conditions have not been identified. Whatever the effect of factors directly involved in manufacturing processes, it is certain that various collateral factors, such as nationality, personal habits, and living conditions, have an important influence.

Whatever the cause of this high mortality from tuberculosis among silk workers may be, it calls for most serious study in order to locate the responsibility and, so far as possible, remove or minimize the cause.

In view of the rather general disposition among writers on industrial hygiene to attribute a high occurrence of tuberculosis to factory dust, it is worth emphasizing the fact, already pointed out, that the silk manufacturing industry is exceptionally free from dust hazards, except perhaps in the plush and velvet mills. Yet, on the whole, the tuberculosis death rate among silk-mill operatives is rather higher than that for workers in cotton and wool mills, where dust is characteristic of certain processes.

Special studies of health conditions in the silk industry in Italy, under the direction of the Department of Industry and Labor, show a similar high mortality from tuberculosis, particularly for the younger age groups. This has been attributed by one writer[1] to the fact that children go to work at so early an age in the silk industry in Italy that they are unable to stand the strain of the work and the unsatisfactory ventilation in the factories. This, the report stated, tends to bring on an anæmic condition which later results in tuberculosis.

In the United States, the laws of most of the states in which the silk industry is conducted aim to protect children from working while too young, and also prescribe their hours of work. It should be remembered, however, that the proportion of young persons working in the silk industry is higher than in most factory industries, and higher than in the other textile industries. It may be that this has a bearing on the high incidence of tuberculosis among silk workers later in life.

---

[1] Dott. Luigi Carozzi. "Contributo allo Studio delle Condizione Igienico-Sanitarie nella Trattura della Seta." Bulletin of the Department of Industry and Labor. Anno IV.N. 7-8 Rome. 1913.

ACCIDENT HAZARD

The accident rate in the silk industry is distinctly low. Thus, in the Pennsylvania Rate Manual,[1] the silk manufacturing industry takes a rate of 25 cents per $100 of payroll as against 55 cents for cotton and wool spinning and weaving, and $1.05 for wool combing, and much higher rates in many other industries.

CONCLUSIONS AS TO HEALTH

The evidence necessary for satisfactory conclusions as to the health of silk-mill workers under different hours-of-work schedules is not in existence. As already noted, there was the same absence of records as in the cotton and wool industries. No morbidity statistics are gathered by the Government, and even the Census mortality statistics by occupation are limited. Special effort was made to see whether information was contained in literature on the subject which would permit of valid conclusions. Here, again, the same paucity of information was developed.[2]

There is no doubt that the mortality from tuberculosis among silk-mill workers is high; it is somewhat higher

---

[1] The following table shows the rates for various industries as quoted in the Pennsylvania Rate Manual.

SILK MANUFACTURING	**$ .25**
Boot and shoe	.40
Rubber boot and shoe manufacturing	.45
Linotype and hand composition	.50
Printing	.50
Cotton thread	.55
Cotton spinning and weaving	.55
Wool spinning and weaving	.55
Shoe findings manufacturing	.60
Electric apparatus manufacturing	.75
Shoe stock manufacturing	.80
Textile dyeing, finishing and printing	**.85**
Rubber tire	.90
Bleacheries	1.00
Wool pulling	1.05
Wool scouring	1.05
Wool combing	1.05
Machine shop, without foundry	1.05
Blacksmithing and shoeing	1.30
Paper manufacturing except writing, bond and ledger	1.35
Can manufacturing	1.50
Iron foundry	1.60
Steel castings	1.60
Rolling mills	1.75
Boiler making	2.05
Pulp manufacturing, sulphur process, no saw or barking mills	2.75
Wool separating (chemical)	3.00
Blast furnace operatives	3.50
Saw and barking mills	3.75

[2] Thus, in Diseases of Occupation and Vocational Hygiene, by Kober and Hanson, covering nearly 900 pages, the only reference to the silk industry noted in the index is a brief reference to the use of chemicals in the manufacture of artificial silk.

than the rate for the wool and cotton manufacturing industries which, in turn, show a higher rate than the general average for all factory industries combined.

With the exception of tuberculosis, however, health conditions among silk-mill workers, so far as these can be judged by mortality statistics, compare favorably with those in other factory industries.

The National Industrial Conference Board, in the summer of 1918, secured the co-operation of a substantial number of establishments for the keeping of careful records of absenteeism in industry over a 24-day period which would show not only the total amount of time lost but also the cause. It is hoped to present a report on the results of this study in the near future. In the meantime a similar record is being kept for another 24-day period which will reflect conditions at the end of the winter. It should be understood that these records will throw little light on the effect of hours of work on health. Probably in most cases there has been no change in work-hours between the periods for which these absence records were kept. In any case it would be necessary to have records covering a much longer time before any safe conclusions could be drawn as to the effect of a single factor such as a change in hours of work.

It is hoped, however, that the keeping of these records for specific periods may lead to keeping permanent records by these establishments, and may encourage other employers to adopt a similar policy. Until such careful records of the amount and causes of absenteeism are kept by a large number of industrial establishments, it will be practically impossible to present valid conclusions as to the effect of hours of work or any other single factor on the health of industrial workers.

Appendix

The following table epitomizes the important data submitted by those establishments which reported the effects on output accompanying reduction in work-hours. For convenience, the information is assembled by hour-groups and the establishments classified according to the effect on production.

In examining the data given in the column "Change in Rates of Wages," the distinction between rates of wages and total wages must be kept clearly in mind. The statement that there was no change in piece or hourly rates when hours were shortened means that weekly earnings were reduced for dayworkers, and for pieceworkers also unless these increased their output. Likewise an increase in efficiency as shown by an increased hourly output does not necessarily mean that total output was maintained.

REDUCED TO 50 HOURS

Production Maintained

Establishments	9
Employees	3,766

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
55	209	TWN	Piece rates increased 10%; increase of 11½% in time rates.	Total output per employee increased for both piece and daywork.
55	150	M	Piece rates increased proportionally. No change in time wages.	Same output for daywork; 10% increase in output for piecework.
55	114	W	Piece rates increased 10 to 15%; 10% increase in hourly rates.	At start 2% decrease in output — later on none.
55	356	W	Piece and day wages increased 10%.	Practically no reduction in total output.
55	268	W N	Piece and hourly rates increased 10%.	Total output per employee remained the same as under the 55-hour schedule.
55*a*	1,713	W V*	Rates increased proportionally.	No effect on output directly traceable to reduction in hours. No figures available. No marked change.
55	106	W T P	Piece rates increased 5%; hourly rates increased proportionally.	No loss in production or in earnings of employees.
55	582	W	Piece and day rates increased 10%.	Practically no effect on output.
54	268	W	Piece rates increased 10%. Same rate for time-workers.	No change in total output per employee or in cost. Better attitude.

Production Decreased

Establishments	49
Employees	18,951

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
55	271	W N	Piece rates increased 10%; same weekly wages for day-workers.	Output for piece and time workers reduced 5%. Tried to speed up and succeeded in some departments.
55	600	G	Piece rates increased 15 to 25%. Hourly rates unchanged.	Decrease of 10% in total output.

W designates broad weaving.
N " narrow weaving.
WV " velvets.
T " throwing.
* " dyeing.

G designates general mill.
P " printing.
M This mill does winding, warping, and quilling.
a This mill reduced to 50½ hours.

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
55	170	W	Increase of 10% in piece and hourly rates.	Decrease of 10% in production.
55	155	W	Piece rates increased 10%. Same weekly wage for daywork.	Loss of 5% in total output.
55	4,582	G	Rates increased proportionally.	Slight loss in production; gain in efficiency.
55	175	W T	Pieceworkers increased 10%. Same weekly wage for time-workers.	A reduction of 10% in production.
55	61	W	Increase of 10 to 15% in all departments. Bonus to weavers.	Production decreased 10%.
55	37	W	Piece rates increased 5 to 10%. Same weekly wage for time-workers.	Less production. Employees more contented but do not work any harder.
55	186	W	Piecework and day wages raised 10%.	Production curtailed 8%.
55	54	W	Increase of 10% in piece and hourly rates.	Production decreased 8%.
55	276	W*	Wages increased.	Loss in output 3.7%.
55	721	W	Increase of about 10%.	Undoubtedly lost production.
55	500	W		Decrease in production but efficiency of operatives increased.
55	400	N		Loss in output greater than loss in time.
55	150	W		Some loss in output but efficiency of operatives increased.
55	494	W	Weavers' rates increased about 20%.	Slight increase in efficiency of operatives. Production decreased.
55	919	G	Piece rates increased 15–25%; hourly rates unchanged.	Decrease of 10% in total output.
55	308	W V*	Piece and hourly rates increased 10%.	Total output per employee decreased 3 to 6% for piecework and 10% for daywork.

W designates broad weaving
N " narrow weaving.
WV " velvets.

T designates throwing.
* " dyeing.
G " general mill.

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
55	188	W	Piece rates increased 10%; time-workers received same pay as before.	Production decreased 10%.
55	50	N	Rates increased proportionally.	Loom records show 8 to 10% loss, but we feel sure that under normal working conditions the reduction in output owing to the reduction of working hours would be very slight.
55	174	W	Increase of 10% all around.	Pieceworkers speeded up and there was no loss of production. Dayworkers did not speed up, with consequent loss of 8 to 10%.
55	122	W		No gain in hourly output.
55	78	N	No change in piece rates; hourly rates advanced.	No increase in output per employee.
55	623	W N	Piece and hourly rates increased 10%.	Loss in output 7.5%.
55	359	N*	No change in piece rates; 11% increase in hourly rates.	Output for daywork decreased 10%.
55	559	W	Piece and time rates increased 10%.	Reduced production 5%.
55	122	W	Piece and time rates increased 10%.	Decrease of 10% in total output.
55	162	W V	Piece and time rates increased 10%.	Total output decreased 3 to 6% for piecework and 10% for daywork.
55	320	N	Piece and hourly rates increased 10%.	Output per employee unchanged for piecework; 10% decrease for daywork.
55	113	W	Piece and time rates increased 10%.	Help better satisfied with shorter hours, and they work harder. Reduction of 10% in time has given a reduction running from 0 up to 5% in production.
55	802	W*	Advanced 10%.	Brought about a loss in production running from 0 up to 5%. Workers better satisfied.
55	163	W	Piecework rates increased 10%.	Reduction in output practically in proportion to the hours worked.

W designates broad weaving.
N " narrow weaving.

WV designates velvets.
* " dyeing.

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
55	40	W	Piece rates increased 10%; same weekly rates for time work.	Output decreased 5% for piecework and 10% for daywork.
55	146	N	Piece and hourly rates increased 10%.	Decrease of 10% in output in both piece and time workers.
55	483	W T	Proportional increase.	Production reduced about 10%.
54	287	T	Proportional increase for piece and day work.	Curtailment in production. Later, new machinery installed and output was maintained.
54	813	W T	Proportional increase for piece and day work.	No important increase in hourly output.
54	164	N	Piece rates increased 10%.	Decrease in output for piece and day work.
54	187	W	Proportional increase for piece and day work.	Slight decrease in production.
54	242	W T	Piece rates increased; time-workers paid same weekly wage.	Output decreased; percent unknown.
54	165	W	Piece rates increased ½%; time-workers same per week.	Immediate reduction of 8% in production.
54	62	W	Piece rates increased 15%; same weekly wage for daywork.	About 8% loss in production.
54	96	W	Piece and time rates increased 10%.	Loss of production about 5%.
54	142	W	Proportional increase.	Decrease in production.
54	356	T		Reduced production.
54	67	W	Proportional increase.	Production decreased about 7%
54	337	W V*		Employers lost in output; employees lost in wages. Went back to 54 hours after a month's trial.
54	1,425	W T S		Loss in production, but efficiency of operatives increased.
54	45	T Sp.		Proportional loss in production.

W designates broad weaving.
N " narrow weaving.
WV " velvets.
T " throwing.

* designates dyeing.
Sp. " spooling, twisting.
S " spinning.

REDUCED TO 51 HOURS

Production Maintained

Establishments	1
Employees	263

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
54	263	W	Proportional increase for time-workers.	Records show no decided change in production.

REDUCED TO 52½ HOURS

Production Maintained

Establishments	3
Employees	2,664

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
55	1,003	G	No change in piece rates; bonus system given.	Output reduced very little, if any, on account of change of hours.
55	252	W	Increase of 10% in wages.	Output for piecework remained unchanged; 2% decrease in output for dayworkers—13% of total force.
54*b*	1,409	W T	Piece wages not changed; day wages adjusted accordingly.	More satisfaction and happiness all around. Production per week stays the same.

Production Decreased

Establishments	2
Employees	977

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
55¼*b*	737	W		Proportional loss of production.
55	240	W	Piece and hourly rates increased 10%.	Pieceworkers maintain output and show greater efficiency; 10% decrease in output of dayworkers.

REDUCED TO 54 HOURS

Production Maintained

Establishments	3
Employees	2,086

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
56	842	S T*		Production was not lessened.
55	1,014	W T		No change in total output.
54¾*c*	230	T*		Production practically remains the same.

W designates broad weaving
T " throwing.
* " dyeing.
G " general mill.

S designates spinning
b This mill was reduced to 52¾ hours.
c This mill was reduced to 53¾ hours.

Production Decreased

Establishments	8
Employees	5,427

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
60	70	T		Decrease of 12% in output of dayworkers.
60	500	T	Proportional increase.	Output lowered in proportion to time.
58	139	W*		Decreased production.
58	2,489	G	7% increase for time work.	Loss in production. Gain in proficiency.
58	425	N T S	No change in rates for piece or time workers.	Total output per employee decreased 6%.
58	228	N		Loss in output has not been as marked as decrease in hours.
58	891	W	Bonus for pieceworkers. Hourly rates increased to make up same weekly wages.	Slight decrease in production.
56	685	W N T		Proportional reduction.

REDUCED TO 55 HOURS

Production Maintained

Establishments	3
Employees	341

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
60	168	Sp.*	No increase in wages. Bonus system.	Output maintained by changing workers from day rates to piece rates.
58	52	T	No change in piece or hourly rates.	No perceptible change in output. Output maintained by speeding up machinery.
58	121	W	Bonus given.	No change in output noticeable.

W designates broad weaving.
N " narrow weaving.
T " throwing.
S " spinning.

* designates dyeing.
Sp. " spooling, twisting.
G " general mill.

Production Decreased

Establishments 6
Employees 850

Previous Hours	Number Employees	Product	Change in Rates of Wages	Statement of Establishment
60	123	T	Same wages for 55 as for 60 hours.	Decrease of 10% in output for daywork.
60	102	Sp.*		Proportional decrease.
60	300	Sp.*		Proportional decrease.
60	105	W		Loss in production about in proportion.
58¼*d*	149	T N	No change in piece or hourly rates.	Slight decrease in production.
57½	71	T	Same pay for 55 hours as for 57½.	Proportional decrease.

W designates weaving.
N " narrow weaving.
T " throwing.

* designates dyeing.
Sp. " spooling, twisting.
d This mill reduced to 55¼ hours.

Publications
of the
National Industrial Conference Board

15 Beacon Street, Boston, Mass.

Research Report No. 1. Workmen's Compensation Acts in the United States — The Legal Phase. 62 pages. April, 1917. $1.00.

Summary of Research Report No. 1. 8 pages.

[illegible]arch Report No. 2. Analysis of British Wartime Reports on Hours of Work as Related to Output and Fatigue. 58 pages. November, 1917. $1.00.

Research Report No. 3. Strikes in American Industry in Wartime. 20 pages. March, 1918. 50 cents.

Research Report No. 4. Hours of Work as Related to Output and Health of Workers — Cotton Manufacturing. 64 pages. March, 1918. $1.00.

Research Report No. 5. The Canadian Industrial Disputes Investigation Act. 28 pages. April, 1918. 50 cents.

Research Report No. 6. Sickness Insurance or Sickness Prevention? 24 pages. May, 1918. 50 cents.

Research Report No. 7. Hours of Work as Related to Output and Health of Workers — Boot and Shoe Industry. 76 pages. June, 1918. $1.00.

RECEIVED JUN 10 1927 DEPARTMENT OF MANAGEMENT

Research Report No. 8. Wartime Employment of Women in the Metal Trades. 80 pages. July, 1918. $1.00.

Research Report No. 9. Wartime Changes in the Cost of Living—July, 1914, to June, 1918. 82 pages. August, 1918. $1.00.

Research Report No. 10. Arbitration and Wage-Fixing in Australia. 52 pages. October, 1918. $1.00.

Research Report No. 11. The Eight-Hour Day Defined. 12 pages. December, 1918. 50 cents.

Research Report No. 12. Hours of Work as Related to Output and Health of Workers — Wool Manufacturing. 69 pages. December, 1918. $1.00.

Research Report No. 13. Rest Periods for Industrial Workers. 55 pages. January, 1919. $1.00.

[illegible]earch Report No. 14. Wartime Changes in the Cost of Living—July, 1914, to November, 1918. 33 pages. $1.00.

[illegible] Report No. 15. Problems of Industrial Readjustment in the United States. 58 pages. $1.00.

Research Report No. 16. Hours of Work as Related to Output and Health of Workers — Silk Manufacturing. 54 pages. March, 1919. $1.00.

INDUSTRIAL NEWS SURVEY

Important industrial news in concise form.
Weekly. $2.00 per year